



# Transportation Synthesis Report

Research and Communication Services  
Wisconsin Department of Transportation  
608-261-8198

[wisdotresearch@dot.state.wi.us](mailto:wisdotresearch@dot.state.wi.us)  
Request a TSR: [pat.casey@ctcandassociates.com](mailto:pat.casey@ctcandassociates.com)

---

## Joint Maintenance and Repair On Doweled, Jointed Plain Concrete Pavement

*Prepared for*  
**Bureau of Technical Services**

*Prepared by*  
**CTC & Associates LLC**  
**WisDOT Research & Communication Services**  
**December 22, 2006**

*Transportation Synthesis Reports are brief summaries of currently available information on topics of interest to WisDOT technical staff. Online and print sources for TSRs include NCHRP and other TRB programs, AASHTO, the research and practices of other transportation agencies, and related academic and industry research. Internet hyperlinks in TSRs are active at the time of publication, but changes on the host server can make them obsolete.*

### **Request for Report**

The Bureau of Technical Services requested information on other state DOTs' practices for repairing joints of jointed plain concrete pavement with dowels. Of particular interest was the percentage of joints typically treated during the first significant repair effort, whether grinding of joints is always part of the process, and how long the repair is expected to last.

### **Summary**

In addition to a search of transportation databases, we surveyed AASHTO Research Advisory Committee representatives and received 20 responses, including Wisconsin's. Our Web search found FHWA direction on joint spacing and grinding practices, emphasizing a maximum joint space of 15 feet and the use of diamond grinding in all but severe material-related joint distress condition. A Michigan directive bases its use of milling on spall sizes less than two feet, with larger damage requiring full rehabilitation. Aside from this Michigan directive and general FHWA guidance, the state of the practice in joint maintenance and repair does not appear to enjoy general dissemination on the Web.

The RAC survey filled that gap. The table of research responses on the next page shows that the 15-foot joint spacing limit is widely embraced, that the first major repair of concrete pavement joints generally falls in the range of 20 to 25 years, and that grinding is not always done, though closer inspection of survey responses shows it is done in the majority of repair situations. The amount of joints repaired in a stretch of highway varies dramatically among the respondents, from one percent to 20 percent. The expectation of service life after the first major repair also varies fairly widely; a conservative, 10-year expectation is common, but ambitious expectations range up to 45 years.

We begin our report with a **Survey Snapshot** of responses from the RAC survey, followed by the detailed **Survey Responses**, and then look at a few guidelines for joint repair, **State of the Practice**.

### **Survey Snapshot**

We sent the following questions to RAC members:

1. What is the distance between pavement joints in your state? In Wisconsin, it's every 15 to 18 feet.
2. When does LCCA indicate the first major joint repair will be required? In Wisconsin, it's at 25 years.
3. When you perform joint repair, how many joints, in number per mile or percentage per mile, do you typically do?
4. Is grinding always a part of this first repair?
5. How long do you expect this first rehab to last before requiring a second?

## AASHTO RAC Survey Joint Repair Practices for Jointed Plain Concrete Pavement

State	Joint Spacing (feet)	1st Major Repair (years)	Joints Repaired (%)	Always Grind?	Next Major Repair (years)
Arkansas	15	25	--	No	10
Arizona	13 - 15 - 17	20	--	No	10 to 14
Delaware	20	25	20	No	25
Georgia	15	25	5	No	25
Iowa	20	30 to 35	5	No	10 to 15
Illinois	15	20	4	No	20
Kansas	15	20	12	No	10
Louisiana	20	20	1	No	--
Missouri	15	25	1.5 (of slab)	Yes	45
New Jersey	15 to 18	10	5 to 20	Yes on 2nd rehab	10
New York	16	25	10	No	15-Oct
Ohio	15	22	4	No	10
Ontario, Can.	14	28	--	Yes	10
Oregon	--	--	--	--	--
Rhode Island	--	--	--	--	--
Virginia	15	20	--	Yes	10+
Vermont	--	--	--	--	--
Washington	15	20 to 30	--	Yes	10 to 25
West Virginia	15	20	--	No	12
Wisconsin	15 to 18	25	--	--	--

### Survey Responses

#### Arkansas

**Distance between joints** – 15 feet.

**When first major repair** – 25 years.

**Joints repaired per mile during typical service** – Not known; pavements less than 20 years old at this time.

**Grinding always?** Probably, if noticeably faulted.

**Service life of first rehabilitation** – 10 years.

**Contact.** David A. Lambert, [David.Lambert@arkansashighways.com](mailto:David.Lambert@arkansashighways.com).

#### Arizona

**Distance between joints** – Staggered at 13, 15, and 17 feet.

**When first major repair** – 20 years.

**Joints repaired per mile during typical service** – Not known. Arizona had not rehabilitated enough doweled PCC pavements yet to know.

**Grinding always?** – No. Grooving may be done, or asphalt rubber or asphaltic concrete friction course overlays may be applied.

**Service life of first rehabilitation** – 10 to 14 years.

**Contact.** Paul Burch, State Pavement Design Engineer, 602.712.8085, [pburch@azdot.gov](mailto:pburch@azdot.gov).

### **Delaware**

Delaware uses no formal LCCA value for scheduling, but typically some repairs are made before 5 years to correct construction. Concrete pavements built before 1970 were rehabilitated with little joint repair by overlaying with HMA. Pavements in the late 1970s experienced rapid ASR deterioration, further skewing conventional repair practice.

**Distance between joints** – 20 feet, since 1975 (45 feet from 1960 through 1974, and 65 feet before 1960).

**When first major repair** – 25 years is expected.

**Joints repaired per mile during typical service** – Typically about 20 percent. Some projects require a much higher percentage, in part because the number of joints requiring attention increases from the time of inspection to the time of repair.

**Grinding always?** For ride deficiency, not for joint repair, unless joint patching will be insufficient to maintain ride quality.

**Service life of first rehabilitation** – Under normal conditions, 25 years or more is expected. The nature of the distress being repaired, however, may reduce this expectation; such conditions may include pavement structure age, traffic loading, severity of distress, etc.

**Contact.** Wayne Kling, Research Engineer, Materials and Research Section, Delaware Department of Transportation. 302.760.2400 or [wayne.kling@state.de.us](mailto:wayne.kling@state.de.us).

### **Georgia**

**Distance between joints** – 15 feet for new pavements; 20 to 30 feet on existing.

**When first major repair** – 25 years.

**Joints repaired per mile during typical service** – 5 percent.

**Grinding always?** No.

**Service life of first rehabilitation** – 25 years.

**Contact.** Myron Banks, Material and Research Branch Chief for Concrete, GaDOT, 404.363.7561 or [myron.banks@dot.state.ga.us](mailto:myron.banks@dot.state.ga.us).

### **Iowa**

**Distance between joints** – 20 feet.

**When first major repair** – Class 3 aggregate, 30 years; Class 3I aggregate, 35 years. For pavements constructed before 1990, first patching occurs around 20 to 25 years, and every 2 years thereafter until overlay.

**Joints repaired per mile during typical service** – Class 3 aggregate, 5 percent; Class 3I aggregate, 5 percent.

**Grinding always?** – No.

**Service life of first rehabilitation** – On new joints, patching every few years after initial patching; 10 to 15 years from patching to overlay.

**Contact.** Chris Brakke, Pavement Design Management Engineer, Iowa DOT. 515.239.1882 or [chris.brakke@dot.iowa.gov](mailto:chris.brakke@dot.iowa.gov).

### **Illinois**

For full LCCA repair projections, see **Illinois Activity Schedule**, attached.

**Distance between joints** – 15 feet.

**When first major repair** – 20 years; more patching may occur until next rehabilitation.

**Joints repaired per mile during typical service** – 4 percent.

**Grinding always?** No; determined on project-by-project basis.

**Service life of first rehabilitation** – 20 years.

**Contact.** LaDonna R. Rowden, Pavement Technology Engineer, Illinois DOT. 217.782.8582 or [ladonna.rowden@illinois.gov](mailto:ladonna.rowden@illinois.gov).

## Kansas

**Distance between joints** – Since 1996, 15 feet.

**When first major repair** – Due to D-cracking aggregates, 20 years.

**Joints repaired per mile during typical service** – 12 percent, plus HMA overlay. Non-D-cracking aggregate pavements have lasted 23 to 26 years to date with no maintenance except joint re-sealing.

**Grinding always?** No.

**Service life of first rehabilitation** – 10 years.

**Contact.** Andy Gisi. [agisi@ksdot.org](mailto:agisi@ksdot.org).

## Louisiana

See **Louisiana LCCA**, attached.

**Distance between joints** – 20 feet (this is maximum allowed, and so is standard practice).

**When first major repair** – Not scheduled; repaired on case-by-case basis. LCCA has joint sealing, cleaning, and patching at 20 years, more patching 10 years later.

**Joints repaired per mile during typical service** – Case-by-case basis; for first LCCA repair, expected to be 1 percent; for second, 2 percent.

**Grinding always?** No.

**Service life of first rehabilitation** – Case-by-case basis.

**Contact.** John Eggers, Senior Concrete Research Engineer, Louisiana Transportation Research Center. 225.767.9103, [johneggers@dotd.la.gov](mailto:johneggers@dotd.la.gov).

## Missouri

**Distance between joints** – 15 feet.

**When first major repair** – 25 years.

**Joints repaired per mile during typical service** – Not specified; replace 1.5 percent of slab area.

**Grinding always?** Yes.

**Service life of first rehabilitation** – 45 years.

**Contact.** John P. Donahue, Pavement Engineer, Missouri DOT. 573.526.4334, [john.donahue@dot.state.wi.us](mailto:john.donahue@dot.state.wi.us).

## New Jersey

**Distance between joints** – 15 to 18 feet. (Formerly used joint spacing of 78 feet, 2 inches with reinforcement and expansion joints, but changed recently; no major projects yet built with new joint design.)

**When first major repair** – 10 years. Seal joints and minor repair at year 10, repair 5 percent of slabs, with underseal and diamond grind at year 20. In practice, we repair when surface distress or IRI require it.

**Joints repaired per mile during typical service.** For 25-year old pavement, 5 to 20 percent; traffic loading and slab thickness will impact joint repair numbers.

**Grinding always?** For the second rehabilitation (at 20 to 25 years), yes; New Jersey aggregates allow pavements to retain skid values for long periods.

**Service life of first rehabilitation** – The second rehabilitation should follow in 10 years; fast-track patching doesn't last as long as normally cured concrete, and precast patches are being explored.

**Contact.** Robert Sauber, New Jersey DOT, 609.530.3861 or [robert.sauber@dot.state.nj.us](mailto:robert.sauber@dot.state.nj.us).

## New York

**Distance between joints** – 4.8 meters (about 16 feet).

**When first major repair** – 25 years.

**Joints repaired per mile during typical service** – 10 percent.

**Grinding always?** No. Consider diamond grinding at first rehabilitation project.

**Service life of first rehabilitation** – 10 to 15 years.

**Contact.** Michael Brinkman, New York DOT. 518.457.4584 or [mbrinkman@dot.state.ny.us](mailto:mbrinkman@dot.state.ny.us).

## **Ohio**

Ohio DOT transitioned from jointed reinforced concrete pavement to jointed plain in mid 1990s, so no rehabilitation has been done to establish historic data.

**Distance between joints** – 15 feet.

**When first major repair** – 22 years.

**Joints repaired per mile during typical service** – 4 percent joint repair and grinding. We expect to repair up to 10 percent of pavement area before considering rehabilitation.

**Grinding always?** No. Asphalt overlay is an option.

**Service life of first rehabilitation** – 10 years.

**Contact.** Roger Green, Ohio DOT. 614.995.5993, [roger.green@dot.state.oh.us](mailto:roger.green@dot.state.oh.us).

## **Ontario, Canada**

**Distance between joints** – 4.25 meters (about 14 feet).

**When first major repair** – 28 years.

**Joints repaired per mile during typical service** – Partial-depth repairs, 35 m<sup>2</sup>/km; full-depth repairs, 63 m<sup>2</sup>/km.

**Grinding always?** Yes.

**Service life of first rehabilitation** – 10 years.

**Contact.** Becca Lane, Senior Pavement Design Engineer, Ministry of Transportation Ontario. 416.235.3513, [becca.lane@ontario.ca](mailto:becca.lane@ontario.ca).

## **Oregon**

Oregon uses continuously reinforced concrete pavement almost exclusively.

**Contact.** Barnie Jones, Oregon DOT. [barnie.p.jones@odot.state.or.us](mailto:barnie.p.jones@odot.state.or.us).

## **Rhode Island**

RIDOT does not repair concrete joints.

**Contact.** Colin Franco, Rhode Island DOT. [cfranco@dot.ri.gov](mailto:cfranco@dot.ri.gov).

## **Virginia**

**Distance between joints** – 15 feet.

**When first major repair** – 20 years.

**Joints repaired per mile during typical service** – Not specified.

**Grinding always?** Yes, for 20-year repair.

**Service life of first rehabilitation** – 10-plus years.

**Contact.** Brian Diefenderfer, Research Scientist, Virginia Transportation Research Council. 434.293.1944 or [brian.diefenderfer@vdot.virginia.gov](mailto:brian.diefenderfer@vdot.virginia.gov).

## **Vermont**

Vermont effectively has no concrete pavement.

**Contact.** William Ahearn, Vermont AOT. 802.828.2561 or [bill.ahearn@state.vt.us](mailto:bill.ahearn@state.vt.us).

## **Washington**

Because Washington DOT experiences faulting rather than spalling, dowel bar retrofitting is the typical joint repair, and is followed by diamond grinding. A WSDOT study on timing and service lives of dowel-bar retrofits will be completed in Spring of 2009.

**Distance between joints** – 15 feet.

**When first major repair** – 20 to 30 years.

**Joints repaired per mile during typical service** – N/A.

**Grinding always?** Yes.

**Service life of first rehabilitation** – If faulting is more than ¾ inches, then 10 to 15 years; if less, 20 to 25 years.

**Contact.** Linda Pierce, State Pavement Engineer, Washington State DOT. 360.709.5470 or [piercel@wsdot.wa.gov](mailto:piercel@wsdot.wa.gov).

## **West Virginia**

Decisions on restoration or repair vary according to pavement condition and funding availability.

When Present Serviceability Index falls below 3.5, overlay or reconstruction is required. Standard joint repair entails excavating the damaged joint and replace with HMA during rehabilitation or overlay. Separate from the Division of Highways is the West Virginia Parkways, Economic Development, and Tourism Division, which is responsible for the West Virginia Turnpike rehabilitation; the WVPED employs diamond grinding regularly; see

[http://www.wvdot.com/7\\_tourists/7\\_tourists.htm](http://www.wvdot.com/7_tourists/7_tourists.htm) for contact information. For West Virginia DOT regulations, see

Design Directive 641 about Concrete Pavement Restoration,

<http://www.wvdot.com/engineering/DD/600/DD641.pdf>. For standard details, see Sheet PVT1 at

[http://www.wvdot.com/engineering/StandardDetails/Vol1/TOC\\_SD1.htm](http://www.wvdot.com/engineering/StandardDetails/Vol1/TOC_SD1.htm).

**Distance between joints** – 15 feet.

**When first major repair** – Concrete pavement restoration considered when PSR reaches 3.5, or at 20 years.

**Joints repaired per mile during typical service** – Varies.

**Grinding always?** No.

**Service life of first rehabilitation** – 12 years for restoration, 8 years for HMA overlay; reconstruction with HMA is 10 years, with concrete 20 years.

**Contact.** James Sloan, West Virginia Division of Highways. 304.558.9748 or [jsloan@dot.state.wv.us](mailto:jsloan@dot.state.wv.us).

## **Wisconsin**

**Distance between joints** – 15 to 18 feet.

**When first major repair** – 25 years.

**Joints repaired per mile during typical service** – N/A.

**Grinding always?** N/A.

**Service life of first rehabilitation** – N/A.

**Contact.** Laura Fenley, Wisconsin DOT. 608.246.5455 or [laura.fenley@dot.state.wi.us](mailto:laura.fenley@dot.state.wi.us).

## **State of the Practice**

The following documents offer a sense of the guidelines issued by FHWA on repair of joints in jointed plain concrete pavement. Though some date from 1990, these documents indicate generally the state of the practice in joint spacing and repair.

**Technical Advisory – Concrete Pavement Joints, Nov. 1990.** FHWA recommends joint spacing no greater than 15 feet for plain concrete pavement slabs; undoweled slabs may benefit from random spacing not to exceed 15 feet. <http://www.fhwa.dot.gov/legisregs/directives/techadvts/t504030.htm>.

**Concrete Pavement Rehabilitation Guide for Diamond Grinding, June 2001.** This FHWA guide notes that diamond grinding is appropriate in most repair or rehabilitation situations, except those dealing with structural deficiency and advanced, material-related distress such as alkali-silica reactions or D-cracking. [http://www.fhwa.dot.gov/Pavement/concrete/diamond.cfm#\\_Toc516391167](http://www.fhwa.dot.gov/Pavement/concrete/diamond.cfm#_Toc516391167).

**Michigan DOT Repair Directive.** In *Special Provision for Concrete Joint Repair, Case A*, directives include partial depth milling and chipping or joints with spalls less than two feet wide. [http://www.michigan.gov/documents/mdot/MDOT\\_CT\\_06JointRepairCaseA\\_7sackmod\\_tes\\_178203\\_7.rtf](http://www.michigan.gov/documents/mdot/MDOT_CT_06JointRepairCaseA_7sackmod_tes_178203_7.rtf).

## Illinois DOT Activity Schedule

<b>ITEMIZED CONSTRUCTION COST — YEAR 0</b>
<ul style="list-style-type: none"> <li>• 100% Shoulder Joint Seal</li> </ul>
<b>REHABILITATION ACTIVITY — YEAR 7</b>
<ul style="list-style-type: none"> <li>• 0.5% Full-Depth PCC Pavement Patching (6 ft Doweled Patch)</li> </ul>
<b>REHABILITATION ACTIVITY 2 — YEAR 10</b>
<ul style="list-style-type: none"> <li>• 1.0% Full-Depth PCC Pavement Patching (6 ft Doweled Patch)</li> <li>• 100% Longitudinal Shoulder Joint Routing &amp; Sealing</li> <li>• 100% Centerline Joint Routing &amp; Sealing</li> <li>• 100% Transverse Joint Routing and Sealing</li> <li>• 1% Full-Depth PCC Shoulder Patching</li> </ul>
<b>REHABILITATION ACTIVITY 3 — YEAR 15</b>
<ul style="list-style-type: none"> <li>• 1.5% Full-Depth PCC Pavement Patching (6 ft Doweled Patch)</li> </ul>
<b>REHABILITATION ACTIVITY 4 (CPR) — YEAR 20</b>
<ul style="list-style-type: none"> <li>• Undersealing Holes Drilled (70% of Joints) (2 holes/Joint/Lane)</li> <li>• Undersealing Grout Solids (1.75 ft<sup>3</sup>/hole)</li> <li>• 4% Full-Depth PCC Pavement Patching (6 ft Doweled Patch)</li> <li>• 4% Full-Depth PCC Shoulder Patching</li> <li>• 100% Pavement Surface Grinding</li> <li>• 100% Transverse Joint Routing &amp; Sealing</li> <li>• 100% Longitudinal/Shoulder Joint Routing &amp; Sealing</li> <li>• 100% Centerline Joint Routing &amp; Sealing</li> </ul>
<b>REHABILITATION ACTIVITY 5 — YEAR 25</b>
<ul style="list-style-type: none"> <li>• 1.5% Full-Depth PCC Pavement Patching (6 ft Doweled Patch)</li> <li>• 1.0% Full Depth PCC Shoulder Patching</li> </ul>
<b>REHABILITATION ACTIVITY 6 — YEAR 30</b>
<ul style="list-style-type: none"> <li>• 2.5% Full-Depth PCC Pavement Patching (6 ft Doweled Patch)</li> <li>• 100% Longitudinal Shoulder Joint Routing &amp; Sealing</li> <li>• 100% Centerline Joint Routing &amp; Sealing</li> <li>• 100% Transverse Joint Routing and Sealing</li> <li>• 1.5% Full-Depth PCC Shoulder Patching</li> </ul>
<b>REHABILITATION ACTIVITY 7 — YEAR 35</b>
<ul style="list-style-type: none"> <li>• 3.5% Full-Depth PCC Pavement Patching (6 ft Doweled Patch)</li> <li>• 2.0% Full-Depth PCC Shoulder Patching</li> </ul>
<b>ROUTINE MAINTENANCE ACTIVITY — ANNUAL</b>
<ul style="list-style-type: none"> <li>• \$505/Lane-Mile/Year</li> </ul>

### MAINTENANCE AND REHABILITATION ACTIVITY SCHEDULE JOINTED PLAIN CONCRETE PAVEMENT (All Traffic Levels)

Figure 54-7A

Louisiana DOT

# LIFE CYCLE COST ANALYSIS

ALTERNATE	YEAR 0	YEAR 15	YEAR 20	YEAR 30	YEAR 40	PRESENT VALUE TOTALS
	7100 ADT	8700 ADT	9400 ADT	10400 ADT	11400 ADT	
<b>A1</b>	<b>NEW JPC PAVEMENT</b> 200mm JPCP 200mm CLASS II BASE COURSE (CRUSHED STONE/RECYCLED PCCP)  CONST. COST: \$ USER COST: \$  TOTAL COST: \$	<b>NO ACTION</b>         TOTAL COST: \$0	<b>CLEAN/SEAL JOINTS</b> SILICONE  <b>PATCHING</b> PATCH 1% OF JOINTS  <b>SHOULDERS</b> COLD PLANE 50MM WITH OVERLAY  CONST. COST: \$ USER COST: \$  TOTAL COST: \$	<b>RETEXTURE</b> TRAVEL LANES ONLY  <b>PATCHING</b> PATCH 2% OF JOINTS  CONST. COST: \$ USER COST: \$  TOTAL COST: \$	REMAINING  INVESTMENT LIFE  0 YEARS      TOTAL COST: \$0	TOTAL INVESTMENT  LIFE = 40 YEARS      CONST. COST: \$ USER COST: \$  TOTAL COST: \$
<b>A2</b>	<b>NEW AC PAVEMENT</b> 50mm AC WEARING COURSE 75mm AC BINDER COURSE 75mm AC BASE COURSE 200mm CLASS II BASE COURSE (CRUSHED STONE/RECYCLED PCCP)  CONST. COST: \$ USER COST: \$  TOTAL COST: \$	<b>STRUCTURE REHAB</b> <b>COLD PLANE 50mm</b> <b>(EXCLUDING SHOULDERS)</b> <b>WITH OVERLAY</b>  40mm AC WEARING COURSE 50mm AC BINDER COURSE 150mm EXISTING AC PAVEMENT 200mm CLASS II BASE COURSE (CRUSHED STONE/RECYCLED PCCP)  CONST. COST: \$ USER COST: \$  TOTAL COST: \$	<b>NO ACTION</b>         TOTAL COST: \$0	<b>STRUCTURE REHAB</b> <b>COLD PLANE 50mm</b> <b>(INCLUDING SHOULDERS)</b> <b>WITH OVERLAY</b>  50mm AC WEARING COURSE 190mm EXISTING AC PAVEMENT 200mm CLASS II BASE COURSE (CRUSHED STONE/RECYCLED PCCP)  CONST. COST: \$ USER COST: \$  TOTAL COST: \$	REMAINING  INVESTMENT LIFE  0 YEARS      TOTAL COST: \$0	TOTAL INVESTMENT  LIFE = 40 YEARS      CONST. COST: \$ USER COST: \$  TOTAL COST: \$